HAZARDOUS MATERIALS

Introduction

The handling of hazardous materials has the potential to impact people, property and the environment. The term “hazardous substance” covers a huge range of items and is essentially anything that can cause harm. This guide covers substances which may be stored and handled as either solids, liquids, gases or even biological species.

The control of hazardous substances falls into many areas of regulation within the UK, Europe and internationally, and fundamentally needs to follow a risk based approach, demonstrating “So Far As Is Reasonably Practical”.

This is a risk based approach in which as an initial step all hazards are identified, i.e. “the things that can cause harm”. The likelihood of these hazards occurring is assessed against existing control measures in place. The study then determines further control measures needed to reduce the risk to an acceptable level.

The level of risk that people, organisations, authorities and regulators deem to be acceptable may vary between industries and countries, but in all cases a documented and agreed matrix of consequence vs. probability vs. acceptable levels of risk must be agreed in order that a balance approach to managing risk can be achieved.

This guide focuses on the general principles of hazardous substance management and not the quantification of risk or what is classed as acceptable or not. It is based on United Kingdom regulation and practice. References are from UK sources.

Effects on People

The effects of dangerous substances on people takes numerous different forms, over short or long time periods and may have an immediate or long term health effect. This can include the effects of vapours, gases and dusts to people via inhalation, digestion or absorption. All factors need to be considered. In the UK the approach taken is specified under the COSHH (Control of Substances hazardous to Health) regulations.

The fundamental approach is straightforward, such that any task being carried out must be subjected to an assessment that clearly understands:

- the hazards of any material being handled,
- what the effects of this substance may be, and
- how the effects can be reduced to an acceptable level.

The complexity and rigour required within each part of this process depends upon the risk calculated.

This assessment can take into account numerous different factors such as:

- time of exposure,
- nature of the material, toxicity, flammability, corrosivity etc,
- the design factors of any equipment being used e.g. local extraction for vapours and dusts, and

- the protective clothing used by an individual.

However at all times an approach of “do we need to use this substance”, “can we use something less hazardous”, “can we use less material”, must always be considered before physical adaptions to equipment and/or (as a last line of defence in the hierarchy of control) the use of PPE (personal protective equipment) are utilised.

It is necessary that any assessments made are documented and then any control measures identified are communicated with adequate training to all persons completing the task. The same principles apply to all “loss of containment of materials” situations, e.g. those involving leaks or spills from process equipment or in laboratory areas.

Further information and guidance is available from the HSE website:

http://www.hse.gov.uk/coshh/

Effects on Property

The use of flammable substances in industry is very common, from the use of solvents for cleaning and in analytical laboratories, to the use of highly flammable materials in chemical installations. Clearly any potential financial loss can be much greater for larger and high value installations, but the basic principles in ensuring the safe handling of flammable materials is the same. In Europe explosive atmosphere regulations are contained in the “ATEX” Regulations and in the UK the “DSEAR” (Dangerous Substances and Explosive Atmospheres) Regulations, which provide good engineering advice.

If substances that can ignite are handled within their flammable range, then a clearly defined ‘Basis of Safety’ assessment is required. This assessment is required for all substances that are present, whether liquids, solids or gases.

So for example this would include the use of Toluene (flammable liquid) in a chemical process, the fuel-gas supply to a boiler and a flour mill processing (explosible) flour dust. If these substances are ignited, then this could result in a destructive fire and or explosion, depending upon how they are being handled and how much is present.

As with all risk based assessments a philosophy of “inherently safe design” should be adopted, in that “is the dangerous substance required” or “can an alternative safer material be used”? Can the flammable materials be handled below their flash point temperature etc? Have the quantities stored across all areas been minimised?

So for flammable liquids and gases and explosible dusts, the assessment required uses the following principles:-

- Is there or can there be a flammable atmosphere present?
    - Are liquids at temperatures above their flash points, are gases at concentrations within their explosive limits, are dusts combustible and within their explosive limits?

- What is the extent of the hazardous area, defined (in regulations) as the “Zone”?

  - This defines the likelihood of a flammable atmosphere being present and how far it extends both within and outside of equipment.

- Are there any ignition sources present within the “Zone”?
  - These could be electrical equipment (including lighting) ignition sources, mechanical equipment ignition sources, static electricity, hot works, etc.

- What measures are in place to prevent ignition sources?
  - This includes adequately designed electrical/mechanical equipment (“EX” rated), earthing to prevent static sparks, “permit-to-work” procedures, operator training, inert-gas blanketing and venting.

- If ignition does occur what measures are in place to prevent or reduce damage to property and people?
  - This includes items such as alarm systems, emergency response plans and incident management, but also extends to the design of the equipment such as relief venting devices and fire/explosion suppression systems. Division of hazardous substances from other areas by spatial separation or compartmentation is another important strategy.

As with all assessments there is a necessity to ensure that all identified hazards and control measures are effectively communicated to employees and that sufficient and suitable training is provided.

Extensive reference and guidance material for safe handling of flammable materials is available via the UK HSE.

http://www.hse.gov.uk/fireandexplosion/

Effects on the Environment

If containment of hazardous substances is lost due to equipment failure, incorrect handling/ storage or processing, this is likely to result in damage to the environment. Hazardous materials by their very nature will have some impact on the environment. So if leaked, this may affect the ground in the area of a spillage, it may result in emissions to air due to evaporation, or if hazardous materials reach a water course this may well impact living organisms.

The key to safe storage and processing of hazardous materials is fundamentally a principle of “keep it in the pipe or vessel” or “primary containment”. If material is released then it should be contained in a bund or other form of suitable “secondary containment”. And if the secondary containment fails then measures should be in place to keep the material on-site or “tertiary containment”. Materials can be stored in a number of different ways which typically includes drums from 5 litres to 200 litres, intermediate bulk containers to 1000 litres ($1m^3$), progressing up to bulk storage tanks, which could be 1000’s of cubic metres in volume. In all these situations the following principles apply:-

- Primary containment must be suitably designed and compatible for the material being stored.
- Liquid storage tanks and vessels should be bunded such that “secondary containment” can contain 110% of the largest container or 25% of the total storage capacity whichever is the largest.
- Bund walls should be impermeable to the material being stored.
- There should be no holes in bund walls for pipes etc.
- Outdoor bunds should be provided with suitable rainwater drains that are normally kept closed.

Bunds can be constructed in various different forms from circa 1m high walls around large liquid storage tanks to low “kick bunds” (or curbs) a few centimetres high which may be used for storage areas of drums and other portable containers in yards or buildings. Secondary containment such as curbs should also be provided for road-tanker discharge and filling stations.

For bulk hazardous liquid storage tanks the use of high-level protection, to prevent tanks being overfilled, is highly recommended.

Advice on the storage of hazardous materials in drums and tanks is available from the HSE. Useful references (available from the website shown) are:

http://www.hse.gov.uk/pubns/books/hsg51.htm - The storage of flammable liquids in containers:

http://www.hse.gov.uk/pubns/priced/hsg176.pdf - Storage of flammable liquids in tanks

http://www.hse.gov.uk/pubns/books/hsg71.htm - Chemical warehousing: The storage of packaged dangerous substances

